



Direct Measurements of (α,n) Reactions for Nuclear Astrophysics with ARIEL

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Reactions induced by alpha-particles that result in the emission of neutrons play a critical role across multiple disciplines of fundamental and applied nuclear physics. However, essential cross-section data for many key (α,n) reactions are either discrepant or entirely unmeasured. In nuclear astrophysics, this deficiency severely impacts models that describe how heavy elements are formed during stellar burning, e.g. via the s-process in massive stars [1,2], and explosive environments, such as neutrino-driven winds of supernovae and neutron star mergers [3]. This problem is especially pronounced for the latter scenario, where entirely unmeasured (α,n) reactions on radioactive nuclei strongly influence the path of a “weak” r-process [4]. However, with the ARIEL upgrade, TRIUMF is uniquely well-placed to provide essential data underpinning nucleosynthesis in both the weak r-process and s-process. Recently, a proof-of-concept measurement was published that demonstrated the use a recoil spectrometer (EMMA) and HPGe array (TIGRESS) to study (α,n) reactions with radioactive beams [5], made possible by newly developed nanomaterial targets [6]. This study has now opened the door for a new experimental programme in weak r-process reaction studies, bolstered by improved selectivity from compact neutron detectors and, through the ARIEL upgrade, clean, neutron-rich beams with efficient charge-breeding. Meanwhile, the DRAGON facility provides an excellent tool to study (α,n) reactions in stellar burning scenarios, again with improved selectivity from neutron detectors (DEMAND array) to expand capabilities beyond radiative capture. In this talk, I will present recent efforts towards an (α,n) reaction programme using facilities in both the ISAC-I and ISAC-II halls, highlighting the many benefits provided by the ARIEL upgrade.

[1] M. Wiescher, et al., Eur. Phys. J. A 59, 11(2023).

[2] J. Frost-Schenk, et al., MNRAS 514, 2650–2657 (2022).

[3] J. Bliss, et al., J. Phys. G 44, 054003 (2017).

[4] A. Psaltis, et al., ApJ 935 27 (2022).

[5] M. Williams, et al., PRL 134(11) 112701 (2025)

[6] V. Godinho, et al., ACS omega 1(6) 1229-1238 (2016).

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